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Range Management

OF GRASSLANDS AND ADJACENT PARKLANDS IN THE PRAIRIE PROVINCES

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Range Management of Grasslands and Adjacent Parklands in the Prairie Provinces

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Cover Photograph: Adjoining fields grazed at different intensities for nine years: Upper left, lightly grazed; upper right, moderately grazed; lower left, heavily grazed; lower right, very heavily grazed.

Photographed at Range Substation, Stavely, Alta.

HIGHLIGHTS

The total number of livestock raised in the Prairie Provinces has not changed greatly since 1920, but cattle have largely replaced horses. However, the stock load per acre is less than 35 years ago because additional range has been developed.

Although cattle have increased at the rate of 60,000 per year since 1920, the increase has followed a cyclic pattern. This pattern depends partly on the amount of pasturage, which in turn is related to the rainfall.

Some 47,500,000 acres of range and 3,000,000 acres of cultivated pasture are used for grazing. Five types of grassland and an extensive parkland contribute to this acreage.

The principles of range management apply to all vegetational types, although application of them may mean slightly different practices in different districts. There are two critical periods—during the early spring when grass growth is slow and in the fall when the crude protein content of the vegetation is less than required. Two- or three-field rotations do *not* produce more gain per animal than continuous grazing. Strong grass stands can be maintained by spring protection and by leaving a sufficient carry-over.

Cultivated pasture crops are recommended for complementary grazing. For the short-grass and mixed prairies, a mixture of crested wheat grass and Rambler alfalfa makes the best spring pasture, and a mixture of Russian wild-rye and Rambler alfalfa is the best supplement for summer and fall. In the fescue and true prairies and in the parkland, creeping red fescue, brome grass, timothy, and Rambler alfalfa are the best pasture crops to complement range.

The present livestock population of about 5,200,000 cattle, 270,000 horses, and 750,000 sheep is a light load on the range resources in years when rainfall is higher than average. However, the same load is a very heavy one when drought reduces grass growth. More pasturage is required if cattle numbers are to be increased substantially.

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INTRODUCTION

Domestic livestock have grazed native grasslands of the Canadian prairies for over 80 years. During this time there have been periods when grass was abundant and others when it was scarce. The supply of grass has depended on precipitation. The cover improved when rainfall was abundant, but deteriorated when there were two or more dry years together. About 47,500,000 acres of grass and bush range and 3,000,000 acres of improved pasture are being grazed in the prairie provinces of Alberta, Saskatchewan, and Manitoba.

Ranchers were the first to study the prairie grasses, and their observations have led to many of the grazing practices recommended today. They realized the low grazing capacity of the native grasslands and the need for feed reserves to maintain herds and flocks through the long, cold winters and the occasional very dry summers. They realized also that adequate stock-watering facilities would ensure better use of grass, and that sheltered areas should be kept for winter grazing.

Dry-land farming expanded rapidly after 1900. This development forced ranchers to graze the poorer and rougher lands. During the period of adjustment the grasslands were used heavily and often overgrazed. This caused concern among stockmen, who, through their organizations, asked the federal government to study range management. The research began in 1927 at the Range Experiment Station, Manyberries. Later, grazing studies were undertaken in the foothills of the Rocky Mountains and in the Great Sand Hills of western Saskatchewan. Grazing surveys have been conducted since 1937 to estimate the carrying capacities of the different types of grassland.

Two major changes have occurred in the livestock load since 1925. There has been a great decrease in horse numbers, and a gradual change from fattening three- and four-year-old steers on grass to finishing calves and yearlings in feedlots. These changes have helped the grass, because there is less winter grazing and because cattle are easier on grass than horses. As a result the livestock load per acre is less than it was 35 years ago.

The range area is extending northward. The North Saskatchewan River was considered to be close to the northern range boundary 30 years ago. Today there are herds 100 miles or more beyond it. North of the river cattle increased from 315,000 to 725,000 (130 per cent) between 1931 and 1956, whereas to the south the increase was only 25 per cent during the same period. It is expected that cattle will continue to increase in the northern area.

Community and co-operative pastures have been established throughout the region, largely on submarginal farm land. The programs are supported by public funds, and include construction of fences and corrals, development of stock-watering facilities, regrassing of cultivated and overgrazed parcels, provision of high-quality sires, and supervision. Nearly 7 per cent of the pasture acreage is controlled under these programs. The pastures provide grazing for about 5 per cent of the cattle population. New pastures are being established each year. These rehabilitation programs have contributed to better land use, added acreage to the grazing resource, and improved the quality of beef cattle.

Since 1931 there has been a considerable increase in the acreage of cultivated grasses and legumes. This has reduced dependence on native grass. Between 1931 and 1956 the acreage harvested for hay increased from 770,000 to 2,880,000, and the land used for improved pasture from 1,600,000 to 3,030,000 acres. Several grasses and legumes have been important in this development. Crested wheat grass, Russian wild-rye, and Ladak and Rambler alfalfa are being used in the drier areas. Brome grass, intermediate wheat grass, timothy, creeping red fescue, Ladak and Rambler alfalfa, and true clovers have proved their value in the districts more favored with moisture. The present rate of increase of sown pasture and hay land of 125,000 acres per year will probably continue.

The results of range and pasture studies are given in this publication. The information applies to the grasslands and the adjacent parkland. Relationships between soil, climate, and vegetation are discussed, and how they affect the use of grass.

PHYSICAL FEATURES

Topography and Soil

The region is an eastward-sloping plain between the Rocky Mountains and the Pre-Cambrian shield. The Missouri Coteau and the Manitoba Escarpment divide the plain into three steppes, each 400 to 600 feet lower than the one west of it.

With few exceptions the soils are derived from glacial drift deposited by the Keewatin ice sheet. The main exceptions are long, narrow band of Cordilleran glacial deposits near the Rocky Mountains, an area in southeastern Alberta and southwestern Saskatchewan where Cretaceous and Tertiary conglomerates, shales and sandstones are close to the surface, and an outcrop of Paleozoic limestone near the Pre-Cambrian shield in the Interlake district of Manitoba and in central Saskatchewan.

Soils of the region are mapped into zones, associations, and textural classes. Three important zones (Figure 1) are the Brown, Dark Brown, and Black. Intrazonal types of the Black soil zone include Shallow Black, Degraded Black, and High Lime. The change in color from brown to black reflects increasing soil moisture efficiency and accumulation of organic matter. The Gray Wooded soil zone extends northward from the Black soil zone. Some characteristics of each soil zone are mentioned in the section on vegetation because, as shown in Figure 1, soil zones and vegetation types are related.

The agricultural use of these lands depends on the quality of the soil and the topography. Level and moderately rolling tracts with clay, silt, or loam soil are used for cereal, forage, and truck crops. Steeply rolling areas and the stony, eroded, shallow, sandy and depressional saline soils produce native grasses and are used for grazing.

Climate

The climate of the region is cool semi-arid, verging into cool subhumid in the parkland. Winters are long and cold; summer rainfall is low and variable.

Air masses from three directions affect the precipitation pattern. Those from the west dry rapidly when crossing the mountain ranges. Those from the north are dry because of their low temperatures. The most important water carriers are air masses moving from the Atlantic Ocean and the Gulf of Mexico. The distances these air masses travel and the obstacles en route make them unreliable sources of rainfall.

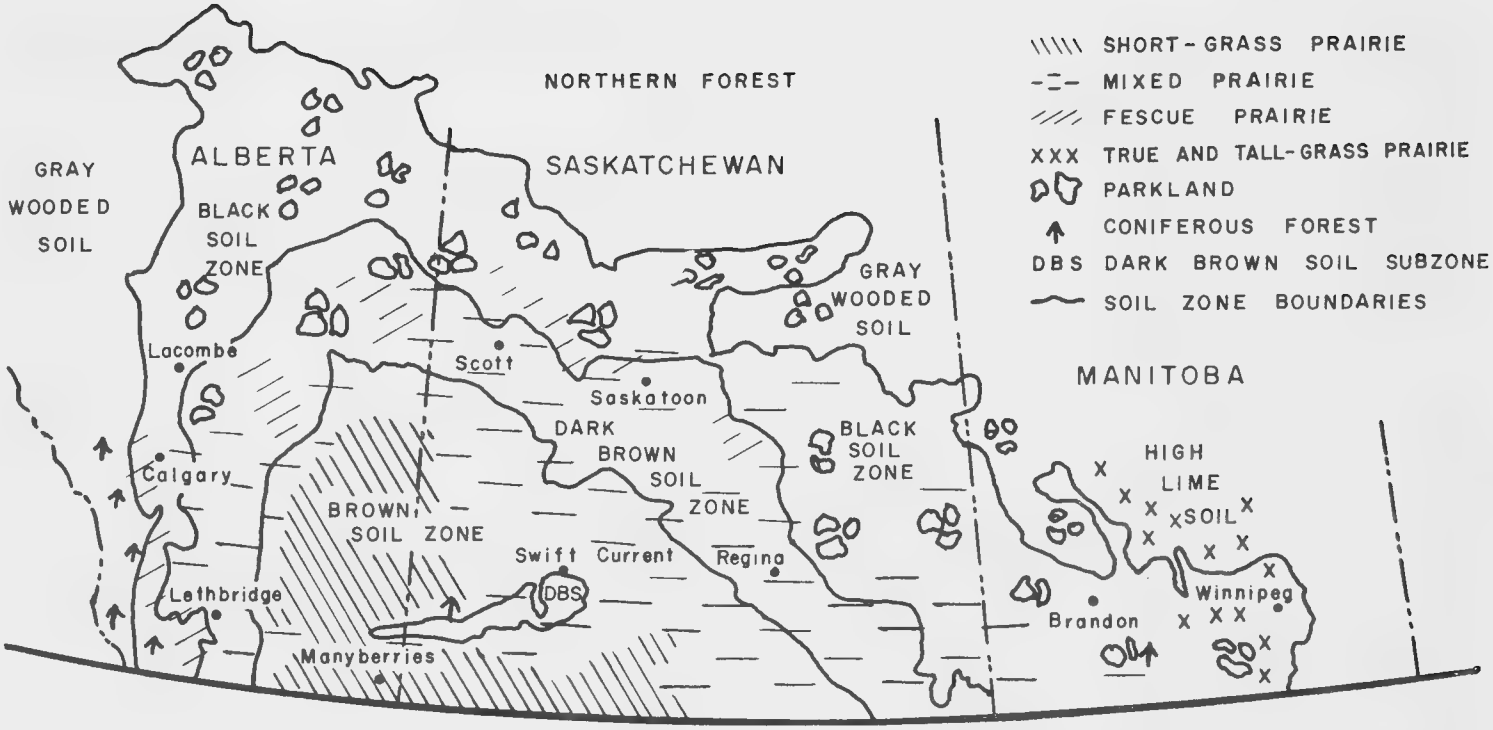


FIGURE 1. Soil zones and grass associations of the Prairie Provinces.

Precipitation data for six localities are given in Table 1 and Figure 2. In Figure 2 the amount shown for each year is the average for that year and the previous two. This method shows trends. Further, growth of native perennial plants under proper management is influenced by precipitation during the two previous years.

There are two points of interest in Figure 2. First, dry and wet years occur in a fairly consistent pattern at all six sites. If drought occurs at one, then drier-than-average conditions are likely at the others, and thus there is little possibility of obtaining extra pasture in other districts. Second, there appears to be a cyclic pattern, as years of more-than-average or less-than-average precipitation occur together with fair regularity. Whereas one dry or wet year affects only the yield, a series of two or more dry or wet years influences the cover. Drought reduces the abundance of the higher-yielding grasses, whereas successive wet seasons favor their increase. Thus, the pattern of precipitation causes yields to vary so that forage may be in short supply or so plentiful that only a small portion of the yearly growth can be eaten.

One other character of rainfall affects the growth of grass. At the border of the prairies where precipitation is greater and evaporation is less, there is a longer period when summer rainfall is more than two inches per month (Table 1). This means a longer growth period and greater assurance of summer pasture.

TABLE 1.—WEATHER RECORDS FROM SIX EXPERIMENTAL FARMS IN THE CANADIAN PRAIRIES

Site[1] and number of years of records	Precipitation Inches		Months with more than two inches of rainfall	P/E ratio[2]	Coefficient of variation of annual precipitation %	Mean temperature, ° F.		
	Mean annual	May-July				January	July	Annual
Lacombe, Alta., 53	17.8	8.3	May-August	1.21	18	8.0	61.3	36.3
Brandon, Man., 71	18.2	7.8	June-August	1.16	21	1.9	67.3	35.9
Scott, Sask., 47	13.8	5.9	June, July	0.64	21	0.0	62.0	33.5
Lethbridge, Alta., 57	16.2	6.8	May, June	0.67	25	17.4	64.6	41.3
Swift Current, Sask., 75	14.8	6.9	June	0.51	22	7.6	66.0	38.3
Manyberries, Alta., 32	12.0	5.2	June	0.39	22	10.2	69.0	40.3

[1]See Figure 1 for locations of sites.

[2]$\text{P/E ratio} = \frac{\text{Annual precipitation}}{\text{April to August evaporation from a free water surface}}$

The mean annual temperature decreases northeastward. This measurement is not in itself a good indicator of growth potential. Table 1 indicates a rather narrow range for mean July temperatures throughout the region, but a considerable difference between mean January temperatures. Consequently the mean annual temperatures largely reflect winter conditions and are not related to the potential for summer production. However, north of the North Saskatchewan River system the low summer temperature rather than the lack of moisture is the main factor limiting crop production.

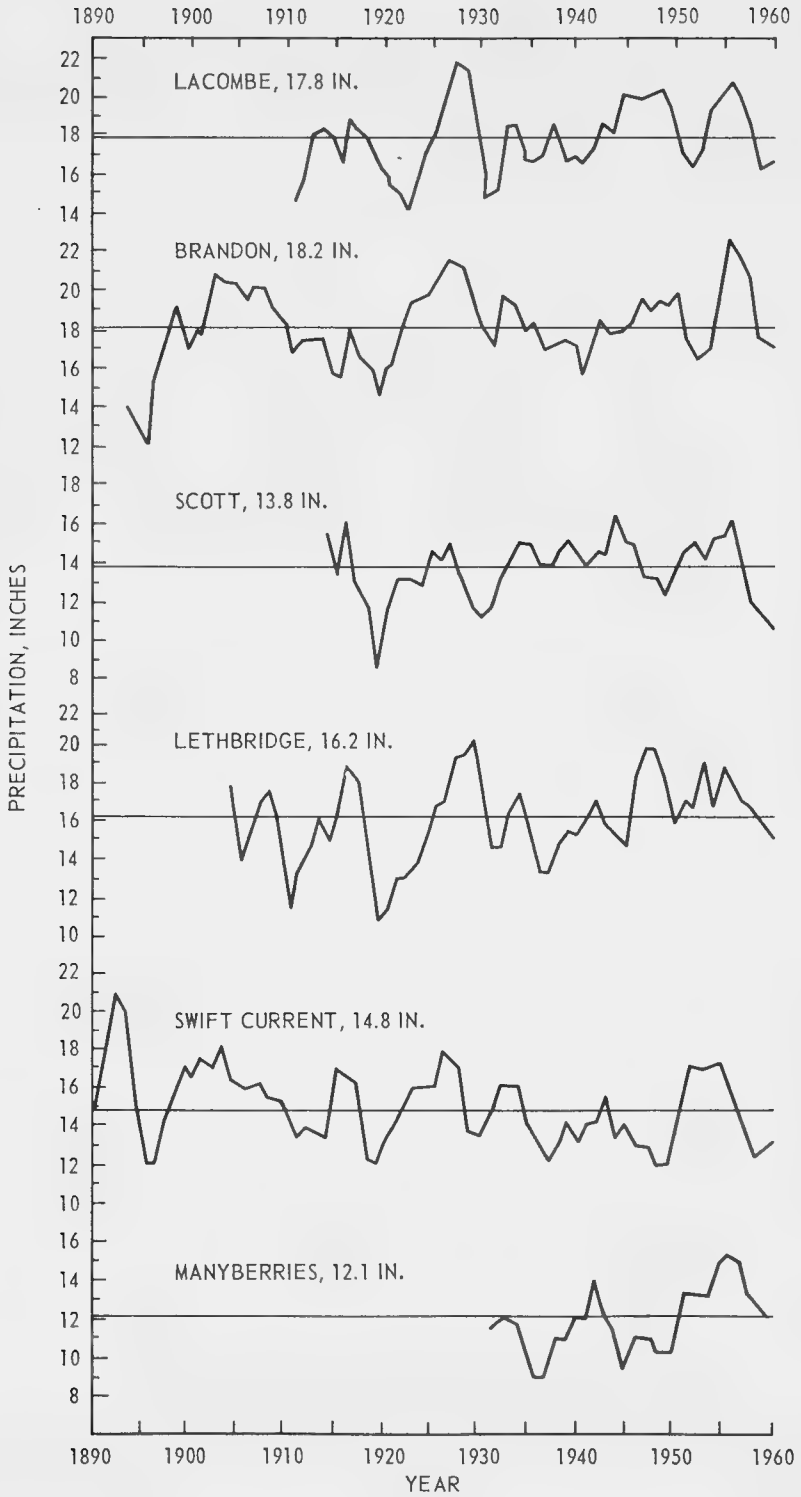


FIGURE 2. Average precipitation at six localities in the Prairie Provinces. The figure shown for each year is the average for that year and the two before.

LIVESTOCK NUMBERS AND PASTURE ACREAGES

Cattle numbers have increased by about 60,000 head per year since 1908 but in a cyclic fashion. Four periods of increase have been followed by three periods of decrease (Figure 3). In general, the increases occurred when grass was plentiful and the decreases when drought reduced grass growth. The downward trends usually started during the third year of the dry periods, and the upward swings in the second year of increased precipitation. The delay in reducing numbers often overtaxed drying pastures, and occasionally caused drastic reductions in cattle inventories.

The changes in sheep and horse numbers from 1908 to 1960 are shown in Figure 3 also. Sheep have affected the grass situation very little, as at no time have they contributed more than 4 per cent to the total livestock load.

Horse numbers have dropped from nearly 2,250,000 in 1926 to about 270,000 in 1960. This reduction made it possible to increase the number of cattle, the replacement being nearly head for head. Without this reduction there would not have been enough grass to increase cattle much beyond the 1930 population of 3,250,000. As the number of horses is not expected to decrease much more, and as there is little more native grass available, the cattle population is not expected to increase greatly beyond its present level until more range and improved pasture are provided.

Figure 3 (two top curves) shows the total numbers of livestock in cattle units and the total acreage of range and improved pasture. The livestock load was less in 1960 than in 1920, and the pasture acreage increased by nearly 10,000,000 acres. These changes reduced the grazing pressure by about 30 per cent. This had led to improvement. In 1920 the range was overgrazed. By 1960 the range was in fair to good condition.

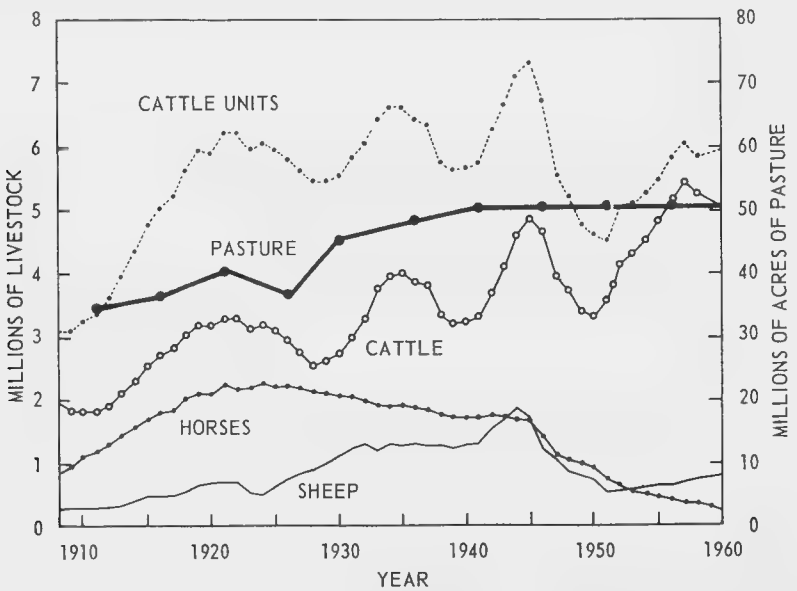


FIGURE 3. Numbers of livestock and acreages of native grassland and cultivated pasture in the Prairie Provinces, 1908–1960. A cattle unit equals 1 cow, 0.8 horses, or 5 sheep.

TABLE 2.—ACREAGES OF NATIVE RANGE AND IMPROVED PASTURE, AND CATTLE INVENTORIES BY PROVINCES AND SIZE OF FARM, ON JUNE 1, 1956[1,2]

Size of farm or ranch Acres	Manitoba			Saskatchewan			Alberta			Total			
	Native grass '000 acres	Improved pasture '000 acres	No. of cattle '000	Native grass '000 acres	Improved pasture '000 acres	No. of cattle '000	Native grass '000 acres	Improved pasture '000 acres	No. of cattle '000	Native grass '000 acres	Improved pasture '000 acres	Cattle '000	Cattle %
Less than 400	1,593	267	381	2,443	194	369	2,721	380	615	6,757	841	1,365	26.3
400—759	1,748	202	308	4,698	317	597	3,103	330	605	9,549	849	1,510	29.1
760—1,599	1,075	89	148	5,551	336	572	3,570	294	568	10,196	719	1,288	24.8
1,600 and over	495	37	35	7,217	281	332	9,939	276	661	17,651	594	1,028	19.8
Total	4,911	595	872	19.909	1,128	1,870	19,333	1,280	2,449	44,153	3,003	5,191	100
Rate of grazing[3] Acres per animal		6.25			11.1			7.8			8.8		

[1]About 3,000,000 acres of range and 250,000 acres of improved pasture in community and co-operative pastures are not included in the totals given in the table.
[2]Information summarized from the 1956 census of Canada and adjusted by recent land records from provincial sources.
[3]Calculations based on total livestock (cattle, horses, and sheep).

Table 2 shows the distribution of cattle on farms of different sizes. Farms of less than 760 acres raise over 55 per cent of the cattle, have developed 56 per cent of the improved pasture, but have only 37 per cent of the native grassland. Farms and ranches larger than 1,600 acres raise less than 20 per cent of the cattle, have developed less than 20 per cent of the improved pasture, yet retain 40 per cent of the native range. These figures show the importance of the smaller units to the livestock industry. Table 2 may distort the situation somewhat, because the smaller units appear to use their range and pasture more efficiently. Actually most units have organized their feed resources to meet their production problems. The larger units practice a more extensive system of grassland management, while the smaller ones make greater use of improved pasture and crop wastes. However, all are grazed to capacity, or above.

VEGETATION

Five grass associations or types are found in the prairies. Four of these, the short-grass, mixed, true and tall-grass prairies, have been described by Weaver and Clements (1938)[1]. The fifth, the **Festuca scabrella** association of Moss and Campbell (1947), is called fescue prairie in this publication. The location of each association is indicated in Figure 1. The grassland merges into parkland at its western, northern, and eastern margins and at higher elevations within the area. Groves of aspen poplar distinguish the parkland region, with white spruce increasing in abundance northward.

The types of grassland differ considerably in species composition. Table 3 indicates the differences in ground cover of the distinguishing species in the various types, although the figures given do not represent the extremes of any species in any type.

The last column in Table 3, "Yield index", is used to estimate forage yield and grazing capacity. The method was developed by Clarke and others (1942) for surveys. To use it to estimate yield, allow 50 pounds of dry matter per 1 per cent ground cover of each species. Multiply this value by the appropriate index to obtain the yield of each species. The sum of the species yields is an estimate of the average total yield. Clipping studies have shown that this estimated yield falls within the extremes of the actual annual yields. During a year of poor growth the estimated yield is greater than the actual yield, but it is less in years of heavy precipitation. The estimated yields and grazing capacities for the eight sites are noted in the two bottom rows of Table 3. Carrying capacity is estimated by the equation:

$$\text{Carrying capacity in acres per animal unit-month}^2 = \frac{660}{0.55 \times \text{pounds dry matter per acre}}$$

Certain of the grasses cure on the stem, that is, they retain their form and most of their nutrients for several months after growth ceases. Pigden (1953) showed that curing is associated with a low lignin content. Other studies have shown that the dry matter of cured western wheat grass and rough fescue is 47 to 57 per cent digestible. The cured grasses contain little crude protein and

[1]Weaver and Clements (1938) do not recognize short-grass and tall-grass prairies as associations. They are considered as associations in this publication.

[2]Animal unit–month: the feed required to support a mature cow or steer for 30 days, about 660 pounds of air-dried grass or its equivalent.

phosphorus but much highly digestible carbohydrate. Many of the grasses in the short-grass, mixed, and fescue prairies cure, whereas few of the true-grass prairie and parkland species do.

TABLE 3.—PERCENTAGE GROUND COVERS, AND ESTIMATED MEAN YIELDS AND CARRYING CAPACITIES, AT TWO SELECTED SITES IN EACH OF FOUR GRASSLAND ASSOCIATIONS

Plant species or other item	Short-grass prairie		Mixed prairie		Fescue prairie		True-grass prairie		Yield index
	Site		Site		Site		Site		
	1	2	1	2	1	2	1	2	
Grasses and sedges									
Blue grama	4.1	7.3	1.8	2.0	—	—	—	—	0.33
Needle-and-thread	0.7	1.3	1.4	0.4	—	—	—	—	1.00
Sandberg's blue grass	1.0	0.8	0.5	—	—	—	—	—	0.60
June grass	0.5	1.0	0.9	1.0	1.2	0.4	0.3	0.6	0.97
Western wheat grass	1.4	0.7	0.7	0.6	0.7	1.6	0.1	0.2	1.28
Sun-loving sedge	0.5	1.7	1.5	1.6	2.2	1.3	0.7	0.5	0.25
Western porcupine grass	—	P[1]	1.9	2.4	0.1	1.6	—	—	1.25
Northern wheat grass	—	P	0.8	0.5	0.6	1.1	—	—	1.28
Rough fescue	—	—	0.5	1.6	4.6	3.2	0.1	0.2	2.14
Idahoe fescue	—	—	—	—	1.1	0.1	—	—	1.00
Parry oat grass	—	—	—	—	5.0	—	—	—	1.10
Little blue-stem	—	—	—	—	—	—	2.3	7.2	1.20
Panic grass	—	—	—	—	—	—	2.3	7.1	0.90
Porcupine grass	—	—	—	—	—	—	0.4	1.4	1.40
Cord grass	—	—	—	—	—	—	1.0	0.8	1.30
Other grasses and sedges	0.4	1.1	1.1	0.4	1.2	2.1	3.0	1.8	—
Forbs and weeds									
Pasture sage	0.5	0.7	1.6	2.5	—	P	P	P	
Moss phlox	0.2	0.5	0.4	0.2	—	—	—	—	
Roses	—	P	0.2	0.1	0.2	0.9	0.35	0.3	
Western snowberry	—	P	0.1	0.1	0.2	0.4	0.35	0.1	
Three-flowered avens	—	—	P	P	0.3	0.6	P	—	
Silvery lupine	—	—	—	—	0.4	0.1	—	—	
Shrubby cinquefoil	—	—	—	—	1.3	0.2	0.2	0.1	
Aspen	—	—	—	—	—	P	1.5	P	
Other forbs and weeds	0.7	0.4	1.2	1.1	3.6	3.5	3.1	1.2	
Little club-moss	6.5	8.7	3.2	4.1	P	0.8	—	—	
Estimated mean annual yield in pounds of dry matter per acre	270	330	425	550	1,080	660	450	1,020	
Acres per animal unit-month	4.5	3.5	2.8	2.2	1.1	1.8	2.6	1.2	

[1] P-present in small amounts.

Short-grass Prairie (Bouteloua-Stipa Association)

Short-grass prairie (Figure 4) occurs in southeastern Alberta and southwestern Saskatchewan where the average annual precipitation is usually less than 14 inches, the precipitation-evaporation (P/E) ratio less than 0.5, and the mean annual temperature over 38° F. It is in the Brown soil zone. The soil is derived from shallow glacial deposits modified by underlying shales and sandstone. The lime layer is between 4 and 10 inches below the surface. The surface soil contains 0.14 to 0.30 per cent total nitrogen. Experience has shown that this land should be used as range.

Blue grama has the highest ground cover even where other grasses dominate the aspect. However, the other grasses may be abundant locally. Needle-and-thread has a higher cover on deeper loam soils. Western wheat grass and June

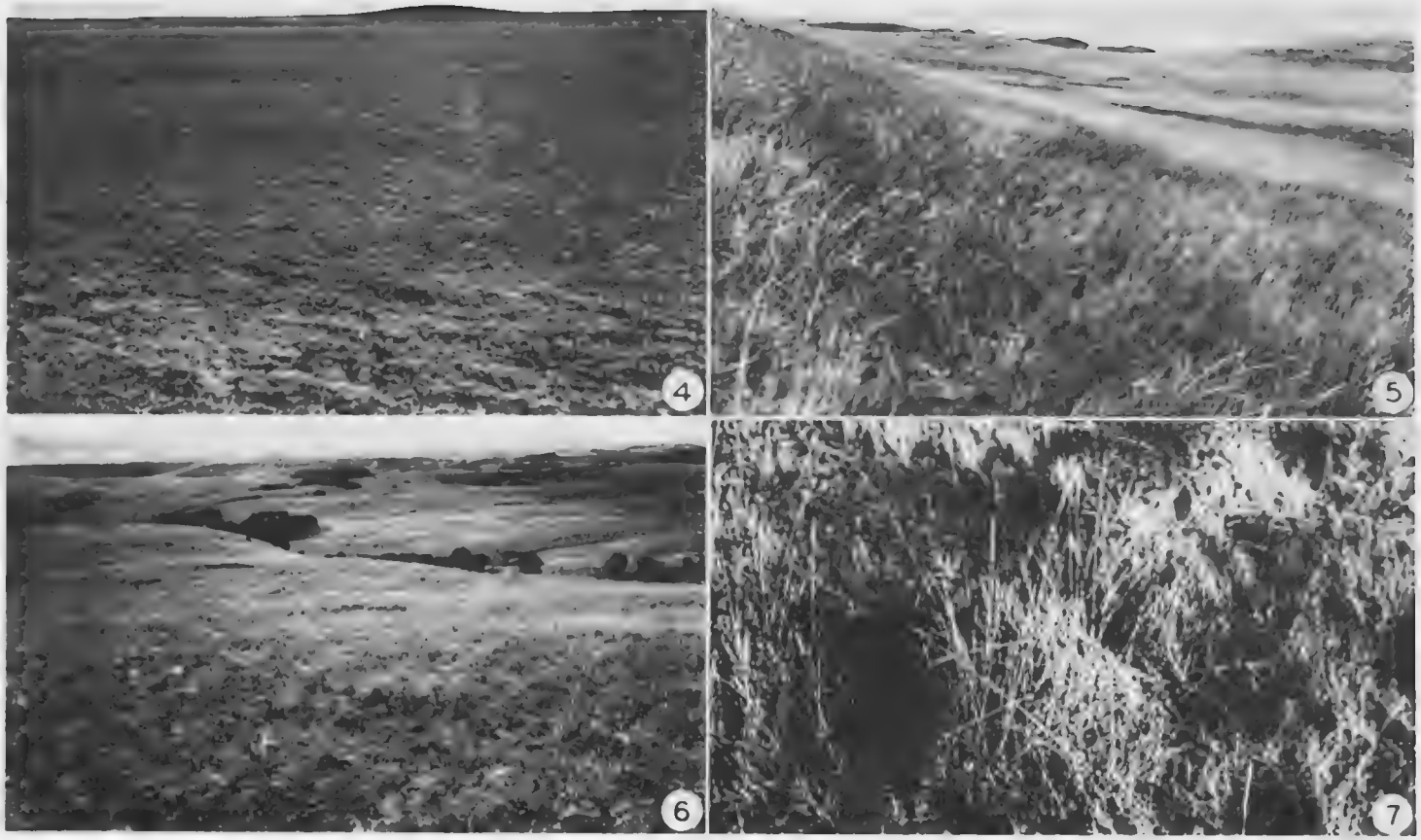


FIGURE 4. Short-grass prairie in southeastern Alberta. The cover is short and dominated by blue grama.

FIGURE 5. Mixed prairie in central Saskatchewan. The cover is dominated by wheat grasses and spear grasses.

FIGURE 6. Fescue prairie in the foothills of the Rocky Mountains. The grass is nearly continuous. The grazing capacity decreases considerably as trees and shrubs encroach on the grassland.

FIGURE 7. Carry-over in fescue prairie in the Cypress Hills. Enough rough fescue is left to ensure strong growth the next spring.

grass are abundant on clay deposits. Sandberg's blue grass is plentiful where erosion has removed the topsoil. The plants of all species are shorter than in the mixed prairie.

Little club-moss is an important constituent of the vegetation. Its cover sometimes exceeds that of all other species combined but usually ranges from 10 to 35 per cent of the total. It provides no forage but helps to prevent wind and water erosion and reduces the effects of tramping. Grasses readily become established in club-moss stands during years of above-average precipitation but rarely during dry years. Little club-moss is not confined to the short-grass prairie but is less abundant in other types unless the range is overgrazed.

Overgrazing of short-grass prairie reduces the amount of needle-and-thread, June grass, and western wheat grass. Blue grama and Sandberg's blue grass may increase as well as pasture sage, broomweed, prickly-pear cactus, moss phlox, and other weeds. The first evidence of overgrazing is a lower yield of forage as the heavier-producing mid-grasses disappear. This is followed by an increase in weedy species and a further reduction in carrying capacity.

Mixed Prairie (Stipa-Agropyron-Bouteloua Association)

Mixed prairie (Figure 5) forms a crescent north of the short-grass prairie, and occurs also in extensive sections of the Peace River district. The mean annual precipitation ranges from 13 to 18 inches, and the P/E ratio from 0.4 to 1.0. The association has developed on soil derived from till, outwash, and lacustrine deposits left by the Keewatin ice sheet. Mixed prairie is found in the Brown, Dark Brown, and Black soil zones where the lime layer is 10 to 16 inches from the surface, and the nitrogen content of uncultivated land varies from 0.18 to 0.40 per cent.

Medium-tall grasses (mid-grasses) are more abundant than in short-grass prairie. With careful grazing they dominate the sward. The first evidence of overuse is the disappearance of the mid-grasses and an increase of blue grama. As overgrazing progresses the pasture weeds increase in density, particularly pasture sage, moss phlox, broomweed, thread-leaved sedge, and crocus anemone.

Mixed prairie is a collection of plant communities, each distinguished by one or more grasses. A community may be only a few acres or several thousand square miles in extent, and is most commonly associated with soil characteristics. Important communities and associated soil types are as follows:

Plant Community	Type of Soil
Western and beardless wheat grasses, green needle grass, June grass	Upland; clay soil
Western porcupine grass, needle-and-thread, blue grama, western wheat grass, and rough fescue	Upland; clay loam and loam
Needle-and-thread, blue grama, sand dropseed, sand grass, June grass, western porcupine grass	Upland; sandy loam
Needle-and-thread, sand grass, northern wheat grass, June grass, Indian rice grass, blue grama, chokecherry	Sandhill prairie; dune sand

Plant Community	Type of Soil
Alkali grass, wild barley, Nuttall's salt-meadow grass, seaside arrow-grass	Sloughs and salt-meadows, soil alkaline or saline
Reed grasses, spangletop, manna grasses, prairie muhly, slender wheat grass, tufted hair grass, awned sedge	Sloughs and marshes; soil not alkaline or saline

Fescue Prairie (Festuca scabrella Association)

In fescue prairie (Figure 6), rough fescue is dominant. This association occurs in the foothills of the Rocky Mountains, in the Cypress Hills, and in much of the Black soil zone in Alberta and Saskatchewan. It requires an average annual precipitation of more than 15 inches, and a P/E ratio of 1.0 or more. The mineral portion of the soil is derived from Keewatin ice sheet deposits, as well as from Cordilleran outwash. The lime layer is 15 to 30 inches below the surface, and the total nitrogen content of the soil 0.30 to 0.80 per cent.

Rough fescue has been credited by Moss and Campbell (1947) as the source of the organic matter in the Black soil zone. The same authors suggest that the vegetation of the Gray Wooded soil zone was originally fescue prairie but that the soil has been modified under deciduous and coniferous forest that invaded the area. Coupland and Brayshaw (1953) agree that the black soils of west-central Saskatchewan developed under rough fescue dominance. Associated grasses include Parry oat grass (in the southern foothills of the Rocky Mountains only), wild oat grass, Idaho fescue, sheep fescue, wheat grasses, porcupine grass, and western procupine grass. Shrubby cinquefoil is a very common shrub in the southern and western sections and is found occasionally elsewhere throughout the association. Aspen groves are a feature of fescue prairie. These gradually become nearly solid aspen-spruce forest at the boundary of the Black and Gray Wooded soil zones. Only the sandy soil and the areas of rough topography are used as range. The level portions where the soil is silt, clay, or loam are cultivated for production of cereals and forages.

True Prairie (*Stipa-Sporobolus* Association)

Almost all of the true prairie has been plowed and the land used for production of cereals and forages. Exceptions are the high-lime soil area in the Lake District of Manitoba, and the sandy soils and areas of rough topography along the Manitoba Escarpment. True prairie has a high carrying capacity during the growing season. However, few of the grasses cure and the nutritive value of the forage decreases after fall frosts.

Tall-grass Prairie (*Andropogon* Association)

Practically all of the tall-grass prairie is cultivated for cereal, forage and truck farming. Relict areas indicate that big blue-stem, Indian grass, little blue-stem, prairie cord grass, and switch grass were the dominant species.

Parkland

Parkland has been called "parkland prairie" because its soil developed under a grass cover. It is grassland interspersed with groves of aspen, which become near solid bush at the boundary of the parkland and the northern forest.

In Alberta and Saskatchewan the parkland developed largely in fescue prairie. True prairie, and to a lesser extent mixed and tall-grass prairies, composed the cover in Manitoba before aspen invaded the area. Parkland has evolved within the last 150 or so years.

There is a gradual change in the tree cover from west to east. In the foothills of the Rocky Mountains lodgepole pine, white spruce and Douglas fir succeed aspen. Jack pine and balsam poplar are plentiful northward, whereas bur oak, balsam fir, and canoe birch increase eastward. The grasses are largely those found in the associations from which the parkland developed, although hairy wild-rye, slender and awned wheat grasses, fringed brome, and wild pea-vine are rather common.

Cattle numbers are high. This is related to a high grazing capacity of native and cultivated pastures, and to the excellent yields of grass-legume hay.

MANAGEMENT TO MAINTAIN YIELD

The management of native grassland has one aim: to maintain a productive sward under a maximum load of animals. This can be done by following a few important rules.

Carry-over

Carry-over is the amount of grass that is left when the grazing season ends. It should be from 40 to 50 per cent of the total growth, or about 20 per cent of the seed stalks should remain uneaten. Plants manufacture their own food, and when they are grazed moderately some of this food is used for further growth and some is stored in the roots. The manufacturing process stops when all leaves are removed. Plants then depend on root reserves to produce new growth, and die when reserves are exhausted. The carry-over (Figure 7) provides the reserve to maintain yield.

TABLE 4.—TILLERING AND WEIGHT OF ROOTS AND LEAVES OF ROUGH FESCUE CLIPPED TO THREE HEIGHTS EVERY 4 WEEKS

Treatment	Number of tillers		Weight per plant at end of test Grams	
	Beginning	End	Roots	Leaves
Not clipped	87	431	14.7	20.2
Clipped to 5 inches	77	427	7.8	16.0
Clipped to 3 inches	81	192	3.0	5.9
Clipped to 1½ inches	73	53	0.7	1.8

The following illustrations demonstrate the value of carry-over. Figure 8 shows the effect of clipping intensity on the roots of rough fescue plants. Table 4 shows that tillering, root weight, and forage production decrease as clipping intensities increase. Similar decreases occur when needle-and-thread is grazed too heavily, as yield is reduced and plants die when over 60 per cent of the growth is removed regularly (Table 5).

TABLE 5.—ANNUAL YIELDS AND SURVIVAL OF NEEDLE-AND-THREAD WHEN VARIOUS PERCENTAGES OF LEAFAGE WERE CLIPPED EVERY 4 WEEKS FOR 4 SUMMERS

Percentage clipped	Leafage per plant Grams	Plants living after 4 years %
20	0.97	100
40	0.96	100
60	0.82	100
80	0.72	77
100	0.60	50

Grazing changes the composition of a sward. In mixed prairie, needle-and-thread often becomes more abundant when a carry-over of 45 per cent or more is maintained. However, the low-yielding blue grama and weeds like pasture sage and thread-leaved sedge become more abundant when grazing is intensified. The changes in percentage composition of the sward that occurred on a pasture near Swift Current over a 10-year period are as follows:

	Not grazed	Moderately grazed	Over-grazed
Wheat grasses	70	20	10
June grass	10	0	0
Needle-and-thread	20	40	10
Blue grama	0	20	40
Thread-leaved sedge	0	0	20
Pasture sage	0	20	20
Total	100	100	100

A carry-over of 40 to 50 per cent every year is an impractical goal. Because yields in successive years may vary from one quarter to three times the long-term average, carry-over will vary from year to year also. On mixed prairie from which forage was removed for six years to simulate moderate grazing, the carry-over ranged from 32 to 73 per cent, and averaged 49 per cent. The sward was not damaged by overuse during the years when growth and carry-over were low, as it regained its vigor when growth and carry-over were above average. The measure of safe use is not necessarily a carry-over of 40 to 50 per cent every season, but a rate of grazing that will leave that amount of forage over a period of years.

Grazing Season

There are two concepts of the term *grazing season*. The first concerns the safety of the animal. With it, the season lasts from the time danger to livestock from spring storms is over until snow prevents foraging. This means seven to ten months of grazing in the southern districts, but less than six months at the northern margin of the parkland.

The second concept concerns the strength of the sward. With it, grazing is deferred until the grasses are manufacturing and storing food. Thus, the date to begin grazing varies from year to year. Budd and Campbell (1959) suggest

FIGURE 8. Sods of rough fescue clipped in the greenhouse at different heights every four weeks for five months. Left to right: not clipped; clipped at 5, 3, and 1½ inches. The decrease in food reserves is indicated by the decrease in root volume as the intensity of clipping is increased.

that dates of readiness for grazing can be linked with the flowering of well-known plants. For the short-grass and mixed prairies, grazing should not start until the golden bean is in full flower—usually late in May; for fescue prairie, when the shooting star is flowering; for the parkland, when native roses begin to bloom.

A second reason to delay grazing is that different grass species start growth at different times. In the short-grass and mixed prairies the order of growth is as follows: Sandberg's blue grass, June grass, western wheat grass, needle-and-

thread, western porcupine grass, and blue grama. The last is six weeks later than the first. In the fescue prairie the order is: rough fescue, Parry oat grass, Idahoe fescue, wheat grasses, and forage herbs; the last is some four weeks later than the first. When grasslands are grazed too early in the spring, only one or two species carry the load and their stands and productivity are reduced. The growth patterns for the short-grass, mixed, and fescue prairies are shown in Figure 9, along with that of crested wheat grass. On all native grasslands, growth

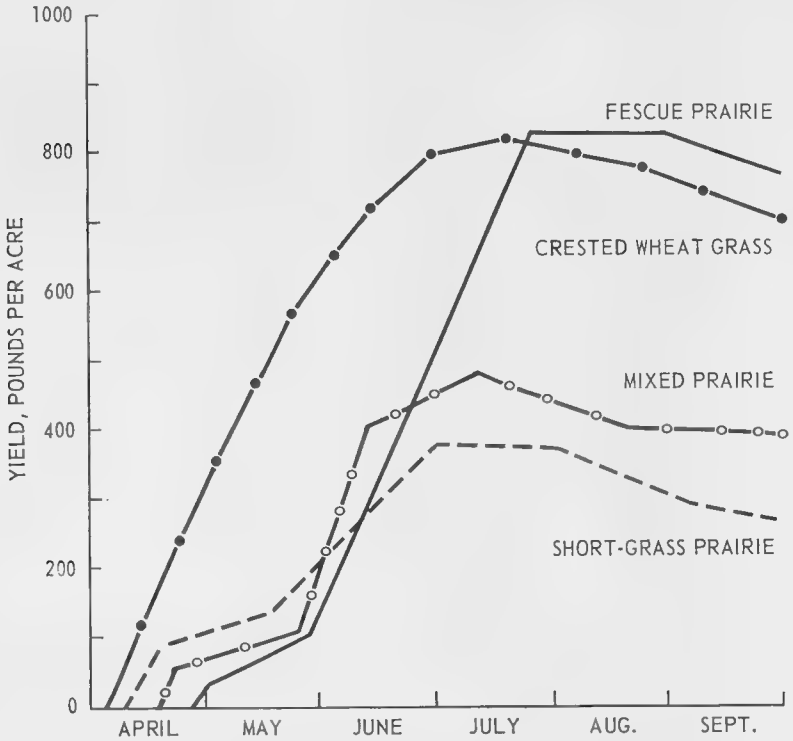


FIGURE 9. Average yields of dry matter per acre from four types of pasture, from April to September, 1947–1953.

is slow until late May but fairly rapid during June and early July. Rapid growth begins when the soil temperature reaches 50 to 55° F. at a six-inch depth. Crested wheat grass begins growth at least two weeks earlier than native grasses and at a much lower soil temperature.

The third reason for deferred grazing is that the longer grazing is delayed in May and June the greater the yield of forage. This is shown in Figure 10, which gives the yields from mixed prairie when simulated grazing was begun in late April, late May, and late June. The yield was highest when clipping was delayed until late June, not much lower when it was delayed until late May, but a great deal less when it commenced in late April.

Grazing Methods

Many stockmen have worked out grazing methods that meet their conditions. Some have two principal pastures, one for summer and a second for winter. Others subdivide the summer range into two fields and graze each every second

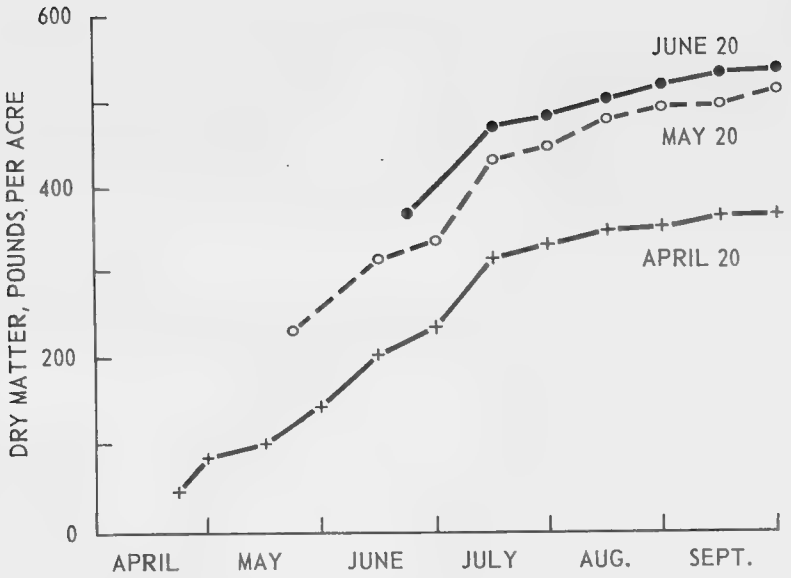


FIGURE 10. Average cumulative yields of mixed prairie when clipping at two-week intervals was begun on three dates, 1947–1953.

year with twice the livestock load, or rotate them in a spring-summer and a summer-fall system. Some divide the summer range into three fields and use each for about one third of the grazing season.

A few of these systems have been studied in grazing tests. The results show that one field grazed continuously produces as much or more beef than two or three grazed in rotation at the same rate. These results apply on short-grass and mixed prairies, and (Table 6) on cultivated grass-alfalfa pastures in the mixed prairie zone. None of the above-mentioned systems has marked advantages, although the grass cover is usually greater when rotations are practiced and the livestock gains per acre are higher for continuous pasturing. Rotational grazing helps the grass because the plants can set seed and maintain food reserves.

TABLE 6.—COMPARISON OF CONTINUOUS GRAZING AND DEFERRED GRAZING ON THREE FIELDS IN ROTATION

Item	Liveweight gain per acre Lb.		Grass cover %	
	Continuous grazing	Deferred rotation	Continuous grazing	Deferred rotation
Short-grass prairie[1]				
Steers	8.7	8.0	7.2	7.4
Cows and calves	13.2	11.8	7.4	8.2
Grass-alfalfa pasture[2]				
Yearling ewes	50.0	42.2	7.3	7.6

[1]Manyberries, Alta., 9-year test.
[2]Swift Current, Sask., 5-year test.

A test at Swift Current has shown the value of grazing crested wheat grass and native grass in rotation on mixed prairie (sandhill type). The crested wheat grass was grazed until late June and the native grass from then to mid-October. This system carried 35 per cent more animals and produced 6 per cent more daily gain per steer than when native grass only was grazed from May to October. Further, the pasture of native grass alone was grazed too heavily, but there was no sign of overuse on the native grass that was protected until late June.

Carrying Capacity

A practical measurement of the carrying capacity of a pasture is the number of acres required to grow enough feed for a beef cow to wean a 400-pound calf. Three or four acres of very good range may be enough, but 40 or more acres may be needed in dry sections of the short-grass prairie.

Large acreages are needed mainly because of carry-over requirements and variation in precipitation from year to year, especially that in the spring. Smoliak (1956) showed that short-grass prairie at Manyberries, Alta., requires 3.7 inches of May and June rainfall to produce an average yearly growth of 317 pounds. However, May and June rainfall at Manyberries ranged from 1.8 to 9.6 inches from 1930 to 1953 and the yields of dry matter from 90 to 825 pounds per acre. From these studies and similar work at Swift Current, equations were developed to show the relationship between May and June rainfall and grass yield (Table 7). No association was found between April rainfall and growth.

TABLE 7.—CORRELATION COEFFICIENTS AND REGRESSION EQUATIONS SHOWING RELATIONSHIP BETWEEN RAINFALL AND GRASS YIELDS

Period of rainfall and vegetation type	Correlation coefficient	Regression equation
April rainfall		
Short-grass prairie	0.05	
Mixed prairie	0.03	
May and June rainfall		
Short-grass prairie	0.86	$y=27+78x$[1]
Mixed prairie	0.74	$y=1+118x$

[1] y=pounds of dry matter per acre; x=inches of rainfall.

On the basis of the regression equation for mixed prairie (Table 7) the annual grass yield ranged from 20 to 1,650 pounds per acre at Swift Current between 1888 and 1960, and averaged 480 pounds. During those 73 years there were evidently 28 years when there was not enough growth to maintain the livestock load. In 23 years there was enough grass to meet grazing needs, and provide a carry-over of less than 40 per cent. Growth exceeded requirements in only 22 of the 73 years.

The carrying capacity of fescue prairie has been studied at the Range Substation, Stavely, Alta., since 1951. Four grazing rates have been tested: 12, 9, 6, and 3 acres per cow and calf for 6 months of summer grazing. Nine acres of grass produced enough feed for a cow and calf, and a carry-over that maintained a stable cover. However, on any individual ranch a larger acreage may be

needed, particularly where eroded hillsides, rock outcrops, poor development of stock-watering facilities, and extensive stands of aspen and willow reduce the grass supply.

The effects of moderate grazing on fescue prairie are shown in Table 8, where measurements of plant cover in 1959 are given for the various rates of use. Rough fescue nearly disappeared and Parry oat grass was reduced considerably under heavy and very heavy grazing. As the grasses disappeared the shrubs and weeds increased. These changes have increased runoff, caused soil erosion, and reduced yield.

TABLE 8.—PERCENTAGE GROUND COVERS FOR FESCUE GRASSLAND IN 1959 AFTER 9 YEARS UNDER FOUR RATES OF GRAZING FOR A 6-MONTH SEASON[1].

Plant species	Rate			
	Light 12 acres per A.U.[2]	Moderate 9 acres	Heavy 6 acres	Very heavy 3 acres
Grasses				
Parry oat grass	9.7	10.0	7.3	5.4
Rough fescue	3.1	2.4	0.5	0.1
Idahoe fescue	2.0	1.8	1.5	1.6
Other grasses and sedges	4.1	3.8	5.9	6.3
Total grasses and sedges	18.9	17.8	15.2	13.4
Weeds and shrubs	5.0	6.5	7.4	8.1
Total ground cover	23.9	24.3	23.6	21.5
Estimated yield of dry matter, lb./ac.	1,025	980	640	520

[1]Range Experimental Substation, Stavely, Alberta.
[2]Animal unit; in this test, one cow and calf.

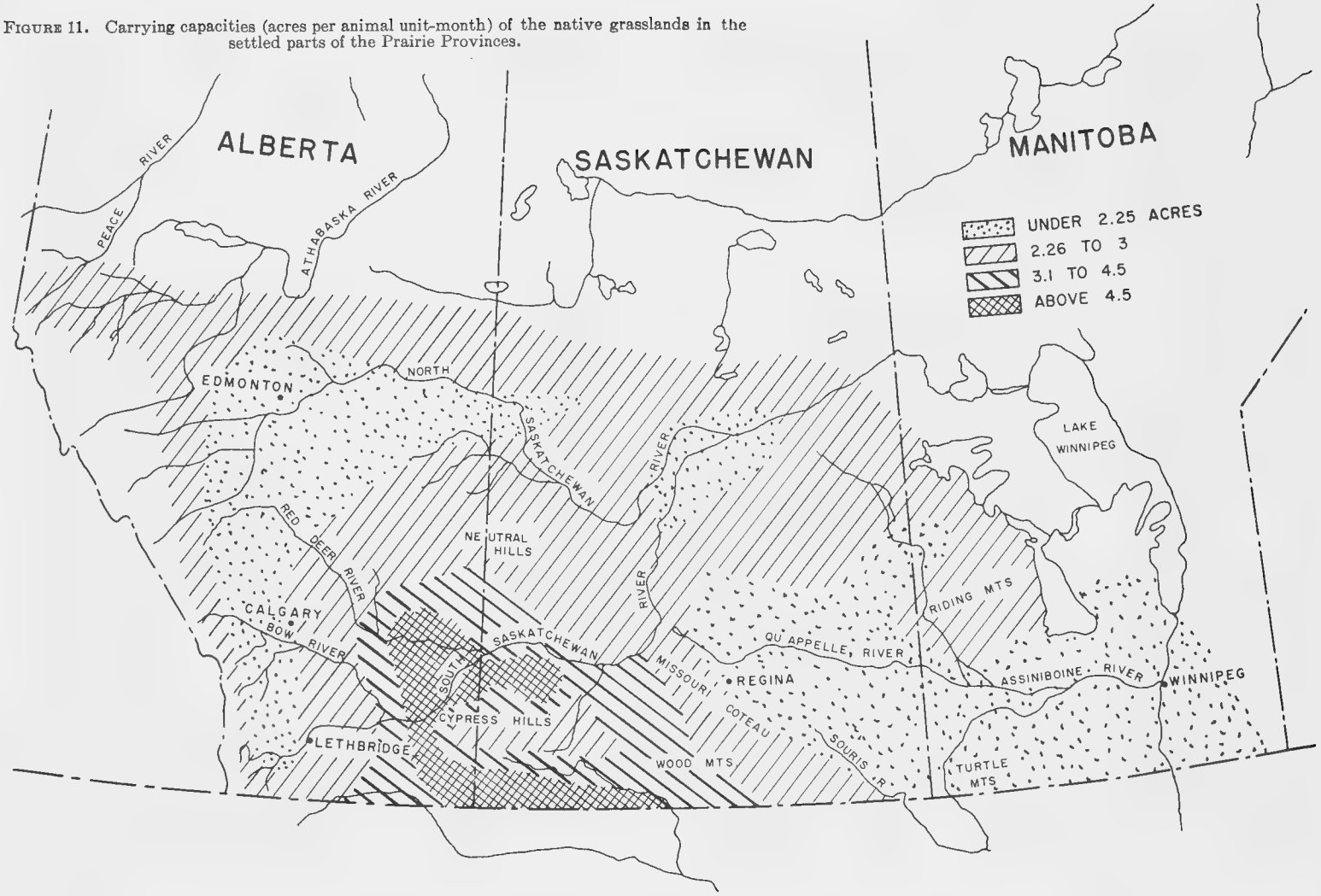
Carrying capacity may be expressed as liveweight gain per acre. Clarke and others (1942) estimated the expected yields of beef at different localities in the short-grass, mixed, and fescue prairies. Their estimates are given, along with actual gains in grazing tests, in Table 9. The range of estimated gain per acre allows for difference in the vegetational cover from point to point. When allowances are made for this factor, there is a close relationship between estimated and actual beef yields.

TABLE 9.—BEEF YIELDS IN POUNDS PER ACRE IN GRAZING TESTS AND BY ESTIMATE ON THREE GRASS TYPES

Grass type	In tests		By estimate	
	Steers	Total cows and calves	Steers	Total cows and calves
Short-grass prairie	8 and 9	11 to 14	7 to 13	10 to 16
Mixed prairie	19	—	12 to 22	13 to 25
Fescue prairie	—	54	23 to 39	25 to 55

Figure 11 shows the carrying capacity of the native range. There are small areas within each class that have higher or lower capacities, but which cannot be shown on a map of this scale. The map indicates the small area of grassland with low carrying capacity (more than 3 acres per animal unit–month) compared

FIGURE 11. Carrying capacities (acres per animal unit-month) of the native grasslands in the settled parts of the Prairie Provinces.



with that of higher capacity (less than 3 acres per animal unit–month). The short-grass and part of the mixed prairies have low carrying capacity. The balance of the mixed prairie and all of the fescue and tall-grass prairies and the parkland are in the higher category. The estimated acreages of high and low carrying capacity are:

Carrying capacity	Acres of	
	Native range	Improved pasture
High (less than 3 acres)	32,800,000	2,420,000
Low (more than 3 acres)	14,700,000	580,000

PASTURE AND HAY RESERVES

Year-round feed reserves are required. Carry-over, moderate rates of stocking, deferred grazing, and crested wheat grass for early-season use are practical means of ensuring reserves during the spring and summer. The following is information on supplementary pasture for the fall, and feed requirements for the winter.

Fall Pasture

Native grasses are low in protein and phosphorus and high in carbohydrates during the fall (Clarke and Tisdale, 1945). Many stockmen overcome the lack of nutritive balance by pasturing annual cover crops, by feeding protein supplements, or by providing grass-alfalfa pastures.

Several perennial crops have been tested for fall pasture. A mixture of Russian wild-rye grass and Rambler alfalfa appears to be outstanding in the Brown and Dark Brown soil zones for this purpose. In a grazing test at Swift Current, fall gains of yearling ewes on different perennial crops showed the superior quality of a mixture of Russian wild-rye and alfalfa:

Pasture	Gain in pounds	
	Per ewe	Per acre
Russian wild-rye grass and alfalfa	9	21
Crested wheat grass and alfalfa	6	14
Crested wheat grass alone	2.5	6

In a test at Manyberries the results were similar to those at Swift Current, and Russian wild-rye pasture yielded three to four times as much liveweight gain per acre as adjacent short-grass range.

Russian wild-rye is valuable in many ways. It is drought- and cold-tolerant, and its stands have a long life. Its protein content is rather high at all times, particularly during the late summer. Troelsen and Campbell (1959) showed it to be highly digestible. Occasionally a seed crop can be harvested before grazing commences. It grows rapidly after fall rains. Its principal weaknesses are that it becomes established fairly slowly (particularly on sandy soil) and it needs a good seedbed.

Rambler alfalfa is drought- and cold-tolerant and is recommended for hay as well as for pasture.

Creeping red fescue, alone or with a legume, is used for fall pasture in many areas of the Black soil zone, where it is as useful as Russian wild-rye under drier conditions. A useful practice is to harvest a seed crop and graze the aftermath. Cattle increase in weight on the aftermath, whereas they lose weight on native range after fall frosts.

Winter Feed Supplies

Hay requirements for maintenance and gain are shown in Table 10. These results were obtained from feeding a mixture of oat hay and alfalfa that contained 18 per cent of oat grain, 12 per cent of crude protein (CP), and 60 per cent of total digestible nutrients (TDN). Five-hundred-pound calves gained $1\frac{1}{4}$ pounds when eating 14 pounds of this roughage daily. Greater gains would result if more grain and less bulk were offered; loss of weight might occur if more straw were added or if the animals ate less.

TABLE 10.—WINTER HAY REQUIREMENTS OF CATTLE FOR MAINTENANCE AND GAIN

Weight of animal Pounds	Pounds of 50-50 oat-hay—alfalfa fodder		Pounds of hay for maintenance for 150 days
	Maintenance	Gain of 1 per day for pound per day	
351 to 450	6 - 8	8 - 10	1,050
451 to 550	9 - 11	12 - 14	1,500
551 to 650	10 - 12	14 - 16	1,650
651 to 750	12 - 14	16 - 19	2,100
1,000-lb. cow in calf	15 - 18	21 - 24	2,400

Table 11 shows the CP contents and TDN ratings for selected feeds. Good-quality hay has a TDN rating of about 60 per cent, and those of less value from 45 to 53 per cent. Cereal straws have TDN ratings of about 40 per cent but all are very low in protein; oil cake, alfalfa, or grain should be added to balance rations containing large quantities of straw. The higher TDN values of irrigated pasture crops are related to the high CP content of the forage as well as the greater availability of other nutrients in young plants.

The percentage of TDN can be considered the pounds of food or nutrients an animal can extract from 100 pounds of feed consumed. If an 800-pound steer requires 15 pounds of forage with a TDN rating of 60 per cent for maintenance, he would have to eat 18 pounds of hay with a TDN value of 50 per cent, or 20 pounds of feed with a TDN rating of 45 per cent, for equal nutrient intake. Hay with low TDN ratings is not eaten readily. Thus, intake may be reduced materially when livestock are fed roughages having low TDN values.

TABLE 11.—PERCENTAGES OF CRUDE PROTEIN (CP) AND TOTAL DIGESTIBLE NUTRIENTS (TDN) IN SELECTED GRAINS, GRASSES, LEGUMES, AND STRAWS

Crop	Grain		Good-quality hay		Straw		Irrigated pasture[2]	
	CP	TDN	CP	TDN	CP	TDN	CP	TDN
Oats	12.7	80	9.5	54–60	4.5	42–48	16	65.5
Wheat	13.0	86	8.3	52	2.8	38	—	—
Barley	12.0	85	9.3	57	3.8	46	—	—
Rye	12.4	85	—	—	2.6	45	—	—
Rough fescue	—	—	7.0	47–55	—	—	—	—
Rough fescue + alfalfa (2:1)	—	—	11.0	58	—	—	—	—
Bluejoint	—	—	7.0	50–57	—	—	—	—
Bluejoint + alfalfa (2:1)	—	—	11.0	58	—	—	—	—
Crested wheat grass	—	—	5.9	58	—	—	—	—
Intermediate wheat grass	—	—	5.9	56	—	—	—	—
Russian wild-rye grass[1]	—	—	6–14	57–61	—	—	—	—
Sedges (native slough hay)	—	—	8.3	59	—	—	—	—
Reed canary grass	—	—	8.0	55	—	—	17	58.0
Alfalfa (Rambler)	—	—	16.0	54–59	—	—	16	68.6
Alfalfa + crested wheat grass	—	—	—	—	—	—	23	66.1
Alfalfa + intermediate wheat grass	—	—	—	—	—	—	23	66.7
Alfalfa timothy	—	—	—	—	—	—	24	66.8
Alfalfa + oat hay (50–50)	—	—	12.0	57–62	—	—	—	—

[1]The range of the crude protein content depends on the amount of fall growth; the higher value is that for hay from irrigated fields; Swift Current results only.

[2]Irrigated pasture crops harvested daily and fed to wethers in digestibility cages.

No feed should be given an exact TDN rating. The stage of grazing or cutting, methods or curing and handling, weathering, as well as the nature of seasonal growth affect nutritive content. Poorly cured hay, or alfalfa that has lost part of its leaves, should have TDN values discounted by 5 to 10 per cent. The advantages of feed mixtures are evident when the TDN values for rough fescue and bluejoint are compared with those quoted for the same grasses mixed with alfalfa (Table 11), because the TDN ratings of the mixtures are much greater than when the grasses are fed alone.

COMMON AND SCIENTIFIC NAMES OF PLANTS MENTIONED

Grasses

Alkali grass	*Distichlis stricta* (Torr.) Rydb.
Awned wheat grass	*Agropyron subsecundum* (Link) Hitchc.
Beardless wheat grass	*Agropyron inerme* (Scribn. & Smith) Rydb.
Big blue-stem	*Andropogon gerardi* Vitman
Blue grama	*Bouteloua gracilis* (H.B.K.) Lag.
Brome grass	*Bromus inermis* Leyss.
Creeping red fescue	*Festuca rubra* L.
Crested wheat grass	*Agropyron cristatum* (L.) Gaertn.
Fringed brome	*Bromus ciliatus* L.
Green needle grass	*Stipa viridula* Trin.
Hairy wild-rye	*Elymus innovatus* Beal
Idaho fescue (bluebunch fescue)	*Festuca idahoensis* Elmer
Indian grass	*Sorghastrum nutans* (L.) Nash
Indian rice grass	*Oryzopsis hymenoides* (Roem. & Schult.) Ricker

COMMON AND SCIENTIFIC NAMES OF PLANTS MENTIONED (Cont'd)

Grasses—(Cont'd)

Intermediate wheat grass	*Agropyron intermedium* (Host) Beauv.
June grass	*Koeleria cristata* (L.) Pers.
Little blue-stem	*Andropogon scoparius* Michx.
Manna grass	*Glyceria* spp.
Needle-and-thread (spear grass)	*Stipa comata* Trin. & Rupr.
Northern wheat grass	*Agropyron dasystachyum* (Hook.) Scribn.
Nuttall's salt-meadow grass	*Puccinellia nuttalliana* (Schultes) Hitchc.
Panic grass	*Panicum* spp.
Parry oat grass	*Danthonia parryi* Scribn.
Porcupine grass	*Stipa spartea* Trin.
Prairie cord grass	*Spartina pectinata* Link
Prairie muhly	*Muhlenbergia cuspidata* (Torr.) Rydb.
Reed grasses	*Calamagrostis* spp.
Rough fescue	*Festuca scabrella* Torr.
Russian wild-rye	*Elymus junceus* Fisch.
Sand dropseed	*Sporobolus cryptandrus* (Torr.) A. Gray
Sandberg's blue grass	*Poa secunda* Presl.
Sand grass	*Calamovilfa longifolia* (Hook.) Scribn.
Sheep fescue	*Festuca ovina* L.
Slender wheat grass	*Agropyron trachycaulum* (Link) Malte
Spangletop	*Scolochloa festucacea* (Willd.) Link
Switch grass	*Panicum virgatum* L.
Timothy	*Phleum pratense* L.
Tufted hair grass	*Deschampsia caespitosa* (L.) Beauv.
Western porcupine grass	*Stipa spartea* Trin. var. *curtiseta* Hitchc.
Western wheat grass (bluejoint)	*Agropyron smithii* Rydb.
Wild barley or foxtail	*Hordeum jubatum* L.
Wild oat grass	*Danthonia intermedia* Vasey

Sedges

Awned sedge	*Carex atherodes* Spreng.
Niggerwool	*Carex filifolia* Nutt.
Sun-loving sedge	*Carex heliophila* Mackenz.
Thread-leaved sedge	*Carex eleocharis* Bailey

Forbs, Shrubs and Trees

Alfalfa	*Medicago* spp.
Aspen poplar	*Populus tremuloides* Michx.
Balsam fir	*Abies balsamea* (L.) Mill.
Balsam poplar	*Populus balsamifera* L.
Black spruce	*Picea mariana* (Mill.) B.S.P.
Bur oak	*Quercus macrocarpa* Michx.
Canoe birch	*Betula papyrifera* Marsh.
Chokecherry	*Prunus virginiana* L. var. *melanocarpa* A. Nels.
Common broomweed	*Gutierrezia diversifolia* Greene
Crocus anemone	*Anemone patens* L.

COMMON AND SCIENTIFIC NAMES OF PLANTS MENTIONED (Cont'd.)

Forbs, Shrubs and Trees—Cont'd.

Douglas fir	*Pseudotsuga taxifolia* (Poir.) Britton
Jack pine	*Pinus banksiana* Lamb.
Lodgepole pine	*Pinus contorta* Dougl. var. *latifolia* Engelm.
Moss phlox	*Phlox hoodii* Richards
Pasture sage	*Artemisia frigida* Willd.
Prickly-pear cactus	*Opuntia polyacantha* Haw.
Roses	*Rosa* spp.
Seaside arrow-grass	*Triglochin maritima* L.
Shrubby cinquefoil	*Potentilla fruiticosa* L.
Silvery lupine	*Lupinus argenteus* Pursh
Three-flowered avens	*Geum triflorum* Pursh
Western snowberry	*Symphoricarpos occidentalis* Hook.
White spruce	*Picea glauca* (Moench) Voss
Wild pea-vine	*Lathyrus venosus* Muhl.
Willow	*Salix* spp.
Little club-moss	*Selaginella densa* Rydb.

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